

## Notes on the Natural History of a Rare *Adelpha* Butterfly (Lepidoptera: Nymphalidae) in Costa Rican High Country

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**Abstract:** The nymphalid butterfly *Adelpha leucophthalma tegeata* Fruhstorfer is a rare member of the macrolepidopterous fauna in the central high (montane) country of Costa Rica. The life stages and developmental time are described for the first time, along with observations on the behavior of the larva and adult. The egg-to-adult developmental time is 51 days on *Pentagonia wendlandia* Hook (Rubiaceae). The egg is laid singly on the dorsal surface of older leaves of the food plant and both the larva and pupa (chrysalis) are very cryptic in morphology, color, and behavior. As with most species of this genus, the adults of *A. leucophthalma* are very skittish. This is one of the few reports on a Central American *Adelpha* from montane environments.

### INTRODUCTION

Many species of *Adelpha* butterflies (Lepidoptera: Nymphalidae) are well known by entomologists working in lowland tropical wet forests of Central and South America. It was Godman and Salvin (1870–1901) who originally pictured several of these species, followed by the descriptions of Fruhstorfer (1915). Most of the lowland tropical species of *Adelpha* are medium-sized butterflies with rich chocolate-brown wings bearing a single, bold white or combination orange and white band on the forewing (fractionated into an anterior orange section and posterior white section), and they are frequently encountered along sunny forest paths and edges where they rest on low vegetation. Although these butterflies are well-known in tropical lowlands, Miller and Miller (1970) have emphasized that very little is known about the more elusive species of this interesting genus in montane regions of the Neotropics. In fact, the apparent paucity of information even on the geographical distribution and taxonomy of montane species of *Adelpha* led Miller and Miller (1970) to their discovery of two rare species in the high country of Hidalgo, Mexico.

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FIG. 1. *Adelpha leucophthalma tegeata* Fruhstorfer. Wild-caught female, dorsal view. Scale in mm.

*Adelpha leucophthalma tegeata* Fruhstorfer (which is taxonomically near *A. diocles* Godman & Salvin, Lee D. Miller, pers. comm.) belongs to that constellation of rare montane species of *Adelpha* in Central America. One of the few adults in my possession is shown in Figure 1. The color pattern of the wings of this little known species represents a significant departure from the more typical appearance of other members of the genus: the dorsal surface of the forewing has a thick, bright orange band and the round spot on each hindwing is vivid white. This species is said to be "rare" in the sense that there are very likely very few specimens in museum collections anywhere, and nothing was known about its natural history. The purpose of the present paper is to describe, for the first time, the early stages of the little known *Adelpha*, along with a larval plant food record, developmental time, and other aspects of natural history.

#### HABITAT AND METHODS

The high country to the northeast of San Jose, the capitol city of Costa Rica, includes a series of mountain valleys of virgin rain forest that lead into the foothills of the Caribbean drainage of these mountains (Central Cordillera). One

of the most prominent of these montane moist valleys is one that occurs east of Volcan Poas. The road that connects San Jose with Puerto Viejo runs along the western ridge of this valley. The altitude of the valley where this study was done is about 1000 m and the depth of the valley itself is about 150 m. The bottom of the valley is the Rio Sarapiquí, and at the study area this river is filled with very large boulders and it is several m in width with very swift current. On the western edge of the river, there is a small plains area that includes virgin forest and heavily-disturbed areas. The habitat ("study area") where oviposition by *A. leucophthalma* was observed consisted of a rectangular patch of very recently cut (1–2 weeks) old secondary forest. This site is just to the right before the girder bridge on the trail from the Puerto Viejo road, down the valley, across the river, and up the other side to a penal colony. Much of the forest had been cleared (machete) by a "squatter" farmer for bananas and cattle.

It was in this patch of freshly-cut forest trees that I saw oviposition by a single female of *A. leucophthalma* at 12:30 P.M. on July 2, 1971. The sky was very overcast with the threat of rain and this butterfly flew low and swiftly among the still fresh leaves of the various felled trees lying in the area. Two eggs were laid on two different old leaves of a sapling-size (4 m tall) individual of *Pentagonia wendlandi* Hook (Rubiaceae).

The two eggs were collected, confined to a clear plastic bag and allowed to hatch in San Jose. The two larvae from these eggs were reared in this manner and supplied with fresh leaves of the food plant. The big, papery, food plant leaves were always retrieved from this individual of *Pentagonia* at the study site and perhaps owing to the heavy rainfall at this time of year, several fresh leaves remained available on the cut tree. Photographs and color transparencies were made of the life stages. Although one larva died in the fourth instar, the other larva survived to adulthood. Measurements (in mm) were made on life stages and gross external features of morphology were noted. Searches were made on subsequent visits for other ovipositing adults and adults of both sexes in general, but to no avail. I was able, however, to observe some adult behavior from the girder bridge high over the Rio Sarapiquí: on two different dates during July 1971, I watched adults flying and resting among leaves of trees overhanging the river near the bridge and about ten m above the water. Other than these observations, adults were very seldom seen. The single adult obtained from rearing was eventually sent to Lee D. Miller of the Allyn Museum of Entomology for identification. Despite many other visits to the area (1972–1973), it was not until July 1973, that I was able to capture another specimen of this very elusive butterfly, and this specimen is shown in Figure 1. It was collected about 60 m from the study site.

Observations were also made on the feeding behavior of the larvae in the plastic bags. Interest here concerned perch construction for resting periods, and the pattern of leaf damage resulting from feeding.



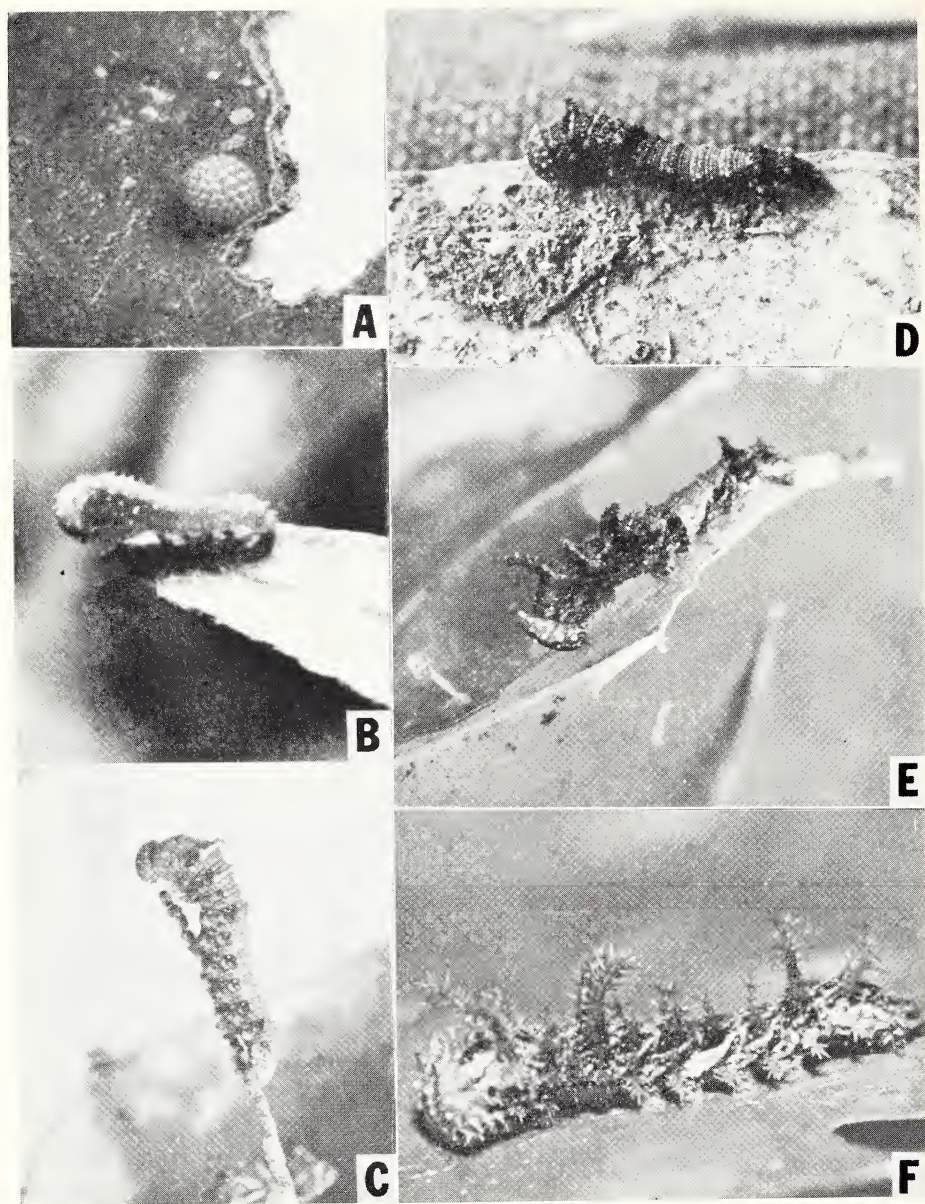


FIG. 2. Life stages and behavior of *A. leucophthalma*. (A) egg, (B) first instar (lateral) resting on perch constructed from the bared apical leaf midrib and silk, (C) second instar in similar position, (D) third instar, (E) fourth instar on perch, and (F) fifth instar (lateral), emphasizing the raised position of the spiracles and first thoracic segment and eighth abdominal segment.

## RESULTS

*Life stages.* The light bluish-green spherical egg (Fig. 2-A) is about 1.0 mm in diameter and the chorionic surface is highly sculptured with ridges forming distinct facets. Tiny hair-like projections arise from the facets, giving the egg a fuzzy appearance (Fig. 2-A). One day prior to hatching, the egg turns light tan in color.

The first instar larva (Fig. 2-B) is 3.0 mm long at the time of hatching, and it possesses a large, orange-yellow head and light green trunk region. Both the head and trunk are covered with rows of very small, tubercle-like scoli. Since I was unable to preserve larval specimens (due to small sample size), the precise distribution and structure of scoli for all instars could not be studied at this time. By the first molt, the larva is about 9.0 mm long. The second instar (Fig. 2-C) has a dark reddish-brown head and dark green body; sets of prominent tubercles become noticeable on the third thoracic segment, and first, third, and eighth abdominal segments (Fig. 2-C, and also Fig. 2-D, for third instar as well). This pattern of prominent, dorsal tubercles, and the arched condition of the third thoracic segment, is very reminiscent of the larva of the North American *Limenitis* (Nymphalidae). In fact, Lee Miller has told me (pers. comm.) that some authors place *Adelpha* as a subgenus of *Limenitis*. By the second molt, the active larva is about 13.0 mm long.

The third instar (Fig. 2-D) is characterized by a noticeable change in coloration: the head has become very dark brown bearing white tubercles, and the body is mottled in shades of dark brown and gray. This very cryptic instar attains a body length of about 17.0 mm by the third molt. The fourth instar (Fig. 2-E) retains the studded condition of the integument of the previous instar, the body being covered with many tiny whitish-gray tubercles, and it is also very cryptically colored in shades of brown and gray. A prominent light gray saddle-like area develops dorsally (but with lateral extensions) in the posterior abdominal region (visible but slightly out of focus in Fig. 2-E). A pronounced transformation has taken place in the size and shape of the prominent tubercles of thoracic and abdominal sectors: all tubercles have undergone considerable elongation, and the set of the metathoracic segment is curved anteriorly. The set of the third abdominal segment is strongly curved towards the posterior end of the body, as is the set on the eighth segment (Fig. 2-E). All of these tubercles bear many tiny stiff hairs. The rich brown color of the tubercles is continuous with the brown coloration of the body. Figure 2-E purposely emphasizes the morphology of the head capsule of this instar. The reasons for this are two-fold: (1) the general shape of the head capsule is now very different in that it is strongly forked dorsally whereas before it was round, and (2) the head capsule color pattern is very different since it now consists of a pair of prominent, vertical cream bands on an otherwise brown background, whereas before it was entirely brown. The head capsule retains the highly studded surface texture of previous instars and as before, all studs are white, cream, or very pale green. By the fourth molt, this instar attains a body length of about 21.0 mm.

As with the transformation to the fourth instar, the advent of the fifth instar is marked by new pronounced changes in gross external morphology. So profound are these changes in appearance that it is worthwhile to emphasize both head and body structure as shown in the series of Figures 2-F and 3-A through C. The system of prominent tubercles of thoracic and abdominal regions has become even more pronounced in this instar: the tubercles are greatly elongated and scoli appear on all of them as prominent projections (Fig. 2-F; Fig. 3-A). The set of lateral, sub-spiracular tubercles relatively reduced in previous instars is now elongated with similar spiny projections. All of these tubercles



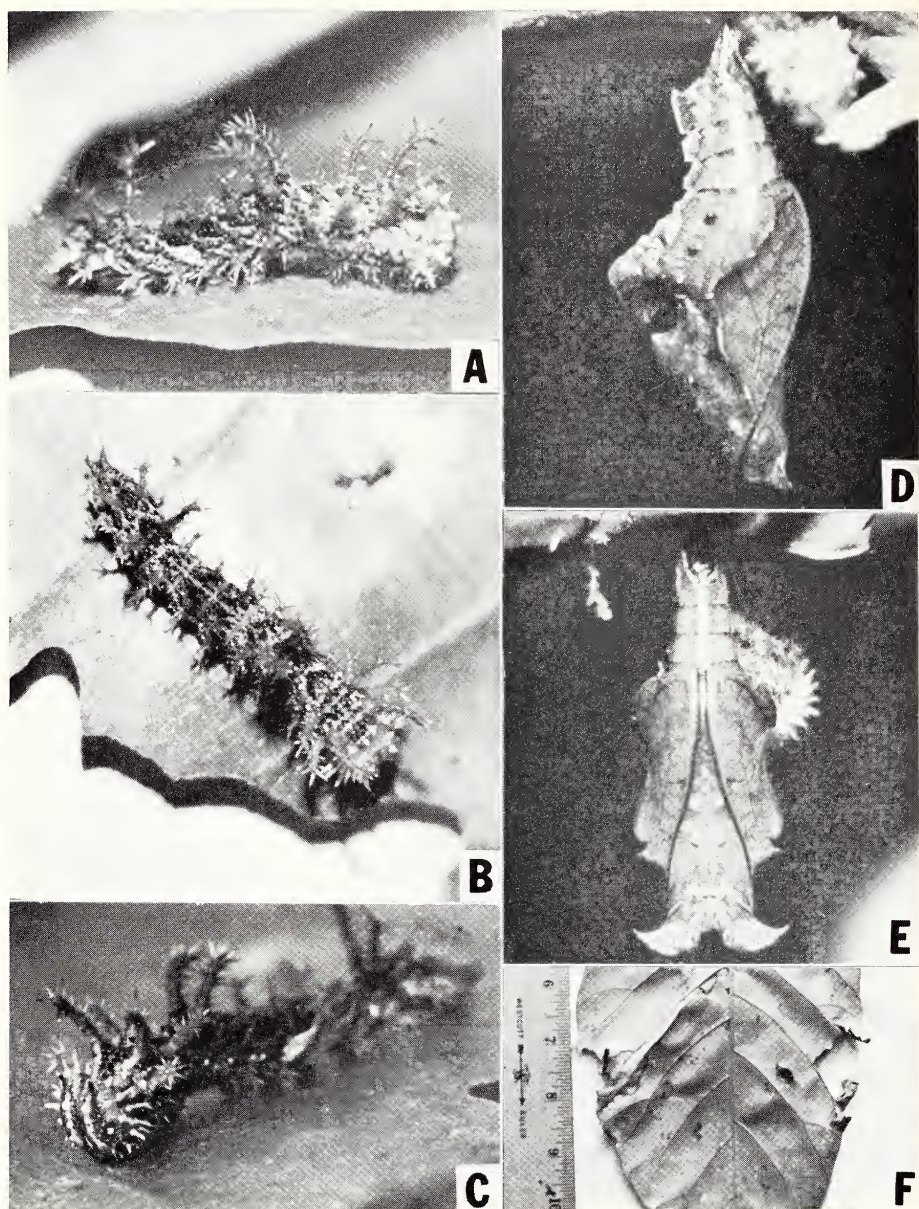


FIG. 3. Life stages and behavior of *A. leucophthalma*. (A) fifth instar, emphasizing the structure and distribution of trunk tubercles, (B) fifth instar (dorsal), emphasizing cryptic resemblance to a moss-covered twig, (C) fifth instar, emphasizing the morphology of the head capsule, (D, E) lateral and ventral of the chrysalis, respectively, and (F) leaf damage pattern by fifth instar larva.

are dull green and there are also green areas on lateral portions of the body. The fifth instar is very spiny in general appearance (Fig. 3-B).

There are also some changes in morphology of the head capsule of the fifth instar, as emphasized in Figure 3-C. Although the coloration remains the same as in the previous instar, there has been considerable expansion on the lateral row of studs that surround the head posteriorly. The two forks remain anterior to this pronounced row of studs on the dorsum, appearing as twin darkened cones. Just below these head capsule forks, there is a pair of large but stubby white tubercles, followed ventrally by a second, smaller pair.

Another conspicuous feature of the fifth instar is the raised condition of the spiracles on the first (prothoracic) thoracic segment and on the ninth abdominal segment (Fig. 3-A). The spiracles of these two segments are positioned more dorsally than those on other segments.

The position of tubercles and scoli deserves comment as they are very noticeable on the fifth instar. There are two rows of spiny tubercles: the uppermost row is dorso-lateral and the second row is sub-spiracular. The first pair of upper tubercles on the metathoracic segment is almost vertical to the body, while those of the first abdominal segment are smaller or more oblique to the body. The next pair is about the same length (7.5 mm) as those of the metathoracic segment, vertical, and positioned on the third abdominal segment. The several segments between this segment and the eighth bear short tubercles, all about the same length as those of the first abdominal segment (4.5 mm). The pair on the eighth abdominal segment is oblique and about the same length as the larger anterior ones; the set on the ninth segment is slightly shorter and more vertical. All of the sub-spiracular tubercles are about the same length (5.0 mm). Other details of tubercle position and structure are omitted since they were not studied due to a lack of preserved material.

Together, the coloration, studded integument of head and body, along with the structure and distribution of spiny tubercles, endows the fifth instar larva of *A. leucophthalma* with a very cryptic resemblance to a short section of moss-covered twig (Fig. 3-B). As to be outlined below, the behavior of the larva suggests further that crypsis in this insect is employed during both resting and feeding. The active fifth instar form attains a length of 26.0 mm prior to pupation.

There is no distinct prepupa, unlike several other neotropical Nymphalidae. The angular pupa (Fig. 3-D, E) is very dark brown but lustrous, with some irregular silver flecks on the ventral thoracic area. It is about 20.0 mm long and resembles a shriveled up dry leaf. The conspicuous lateral and ventral aspects of the pupa are self-explanatory in Figure 3-D, E.

The total egg-to-adult developmental time is 51 days for the single individual reared to the imago. The egg stage lasts eight days, the total larval period 31 days, and the pupa 12 days. This individual was a male.

**Larval Behavior.** Upon hatching, the first instar larva immediately devours the empty egg shell; how consistent this behavior pattern is among the species and subspecies cannot be determined from this study. As the egg is usually affixed to the leaf either at the edge or near a hole, the larva then moves to the very tip of the leaf. Throughout the first three or four instars, the larva when not feeding rests on a perch made from the bared midrib of the leaf. If the larva is disturbed experimentally while it is feeding, its immediate response is to crawl rapidly back to the perch and stay there for several minutes. This behavior pattern is very



consistent. Very interestingly, the larva during the first two instars weaves a thick, silvery mat of silk around the midrib section forming the perch, and the mat extends partially onto the intact leaf surface. This structure is very much reminiscent of the woven construction of the hibernating tube of first or second instar *Limenitis* at northern latitudes. But here there is no enclosure (tube) formed after the mat is built. The resting perch of younger instars is shown in Figure 2-B, C.

The fifth instar rests on both sides of food plant leaves under laboratory conditions. It generally rests near large brown spots on the edges of these leaves, and it feeds along the edges rather than from the tip (Fig. 3-F). During all instars the larva is a diurnal feeder. When disturbed, the fifth instar ceases to feed and folds the head down beneath the thoracic region. The spines on the prominent tubercles do not produce a rash on the back of the hand when they are rubbed against them, suggesting that the spines are functional as part of a general morphological adaptation for passive defense (crypsis) rather than for offensive chemical defense against attackers.

*Adult behavior.* What little can be stated concerning adult behavior in this butterfly has to do with oviposition and play. Oviposition is very fast: there is a rapid flight movement over the foliage with sudden stops to lay a single egg. It is so fast that I was not able to determine the stance assumed during oviposition. The egg is laid on the dorsal leaf surface: in the two instances observed, one egg was laid near the edge, and another (on a different leaf) was laid near a hole in the interior region of an old leaf (Fig. 2-A).

As typical with many species of *Adelpha*, adults of *leucophthalma* exhibit flying play behavior amidst sun-flecked leaves overhanging the Rio Sarapiquí. I define play behavior as the flitting among different leaves by adults, including momentary perching on leaves in sunny places. It is likely that both sexes are involved. Based on these observations, and the fact that oviposition occurred on the leaves of a felled *Pentagonia* that is four m tall, it is likely that adults are active primarily in forest strata that occur about four to six m above the ground. On the morning of July 4, 1973, a sunny day at the study site, I observed one fresh adult of *A. leucophthalma* resting on the broad leaf of an epiphytic palm about five m from the ground; this was in the uncut forest about 100 m from the cut (now regenerating) forest site. I was unable to net this individual. This individual was resting with the wings outstretched, possibly thermoregulating, as noted for other montane species of *Adelpha* (Miller and Miller, 1970). I have never seen adults resting with their wings closed in this species.

#### DISCUSSION

*Adelpha leucophthalma* is probably absent from the tropical lowlands of Costa Rica. I have never seen it either in Guanacaste or in Sarapiquí ("terre



caliente"). As for high country, I have seen it both at Cuesta Angel, the site of the present study, and also southwest of here at Bajo la Hondura. At both of these localities, the insect is solitary, and I have seldom seen more than three adults on a given day. The factors contributing to the apparent "rarity" of this butterfly in Costa Rican high country are not known at this time. Based on these field observations, the scarcity of the species in museum collections is indicative of it being rare in the wild. In the tropical lowlands, many other species of *Adelpha* appear to be locally abundant.

Miller and Miller (1970) suggest that some *Adelpha* are *Quercus*-feeders as larvae; *Quercus* is a member of the Fagaceae (beech family). The present record of *A. leucophthalma* on a rubiaceous food plant may be a first record for a member of this genus on something other than oaks.

In terms of adjusting to the local community of plants and animals, the natural history of this *Adelpha*, as in other species of this genus, entails an adaptive response to some spectrum of potential predators in the form of crypsis. As perceived by humans, this crypsis is best expressed in this insect during the larval and pupal (chrysalis) periods of ontogeny. Such adaptations are very likely most effective against attacks by visual-hunting predators such as foliage-foraging insectivorous birds, lizards, and perhaps larger predatory arthropods possessing compound eyes capable of color discrimination. The behavior of the larva in returning to a thin, isolated perch upon disturbance is interpreted here as a means of positioning itself in a place where (1) crypsis is enhanced, and (2) it is less accessible to predators. It is doubtful, however, that the latter aspect is an adaptation to large vertebrate predators that glean leaves for insects, but rather it may be most effective against ants and other smaller predatory arthropods that hunt by odor and tactile means in addition to vision. A bird or lizard would gobble the larva very quickly should the crypsis be penetrated by the searching behavior of these forms, but there may be more time for escape when attack is by a single ant or beetle. The predator-defense adaptations of the egg and adult stages are obscure. The hair-like projections from the egg may be functional in discouraging attack by predatory insects. Depending on the size and diversity of the guild of leaf-chewing insects that attack the older leaves of *Pentagonia* at the study site, the eggs of this butterfly and those of other insects may be subject to varying degrees of predation through passive uptake as leaves are consumed. The adults are very swift, agile fliers, as are all members of the genus. The general habits of the adults of several insular species of *Adelpha* have been given in Barcant (1970), and those of adult *A. leucophthalma* conform closely to *A. naxia* (Fldr.).

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